

APPLICATION GUIDELINES FOR ZB*KC/ZB*KCE COPELAND SCROLL® REFRIGERATION COMPRESSORS 7 TO 15 HP

Introduction

The Copeland Scroll® ZB*KC/ZB*KCE refrigeration compressor product offering has expanded to include higher horsepower models. These new models include 7-15 Hp and produce between 50,000 Btu/H and 114,000 Btu/H at 20/120°F using 60 Hz electrical power. This bulletin covers the application parameters recommended for operating these compressors properly.

Nomenclature

The ZB*KC/ZB*KCE refrigeration scroll model number includes two digits that indicate the amount of cooling capacity in thousands of Btu/H at the 60 Hz ARI rating point (20/120°F) with R404A in the third and fourth location. (e.g. ZB92KC produces approximately 92,000 Btu/H). For actual compressor performance information please visit Emerson Climate Technologies Online Product Information at www.emersonclimate.com

Operating Envelope

The Copeland Scroll refrigeration models can be used with a variety of refrigerants. **Table 1** shows these selection options.

The operating envelopes are depicted in Figures 1A, 1B, 1C, 1D, 1E and 1F.

TABLE 1		
Model	Refrigerant	Lubricant
ZB50KC/E	R22/407/R404A/507/134a	MO/POE
ZB58KC/E	R22/407/R404A/507/134a	MO/POE
ZB66KC/E	R22/407/R404A/507/134a	MO/POE
ZB76KC/E	R22/407/R404A/507/134a	MO/POE
ZB88KC/E	R22	MO/POE
ZB95KC/E	R22/R404A/507/134a	MO/POE
ZB114KC/E	R22/R404A/507/134a	MO/POE
ZB56KC/E	R22/R404A/507/134a	MO/POE
ZB68KC/E	R22/R404A/507/134a	MO/POE
ZB75KC/E	R22/R404A/507/134a	MO/POE
ZB92KC/E	R22/R404A/507/134a	MO/POE
ZB11MC/E	R22/R404A/507/134a	MO/POE

Figure 1A
ZB*KCE (excluding ZB95KCE & ZB114KCE)
Application Envelope for R404A/R507 MT
Applications 7-15Hp

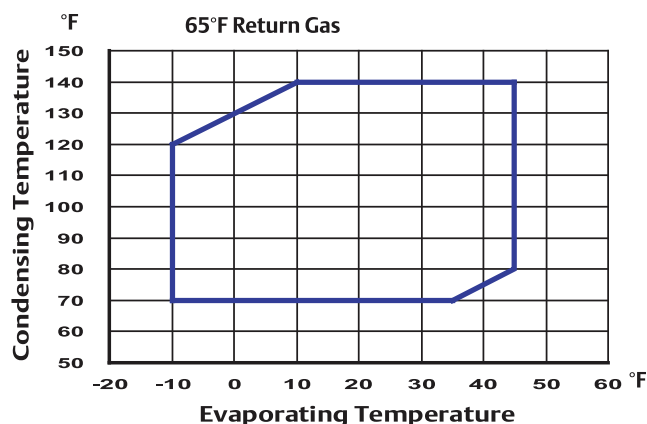


Figure 1B
ZB95KCE & ZB114KCE Application Envelope for
R404A/R507 MT Applications 7-15Hp

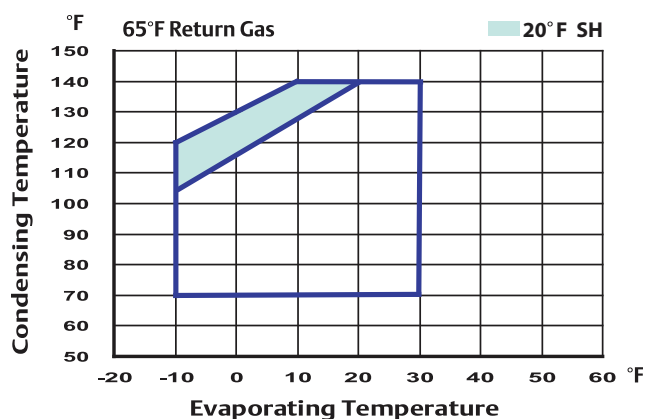


Figure 1C

ZB95KCE & ZB114KCE Application Envelope for R404A/R507 HT Applications 7-15Hp

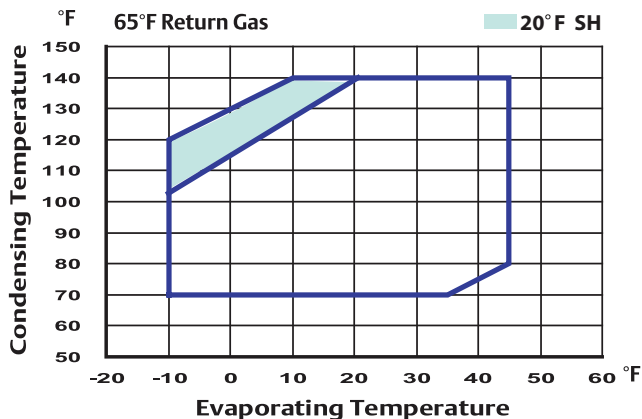


Figure 1F

ZB*KCE Application Envelope for R134A HT Applications 7-15Hp

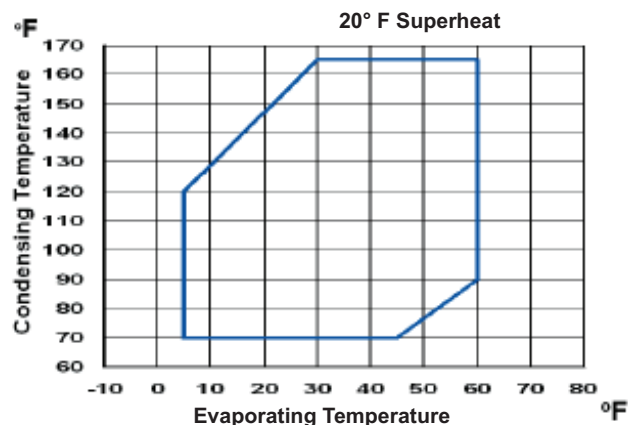


Figure 1D

ZB*KC (excluding ZB95KC & ZB114KC)
Application Envelope for R22 HT Applications 7-15Hp

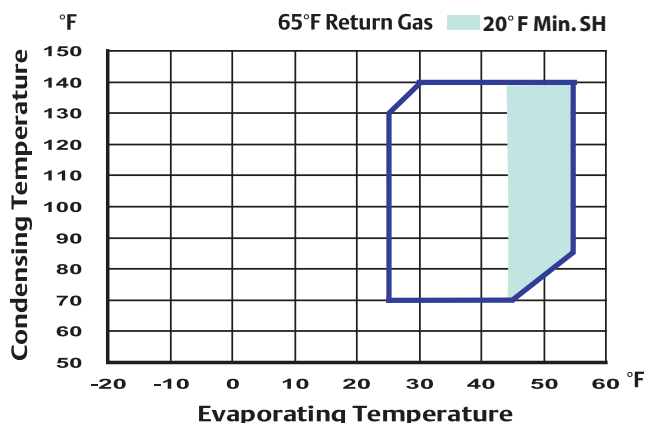
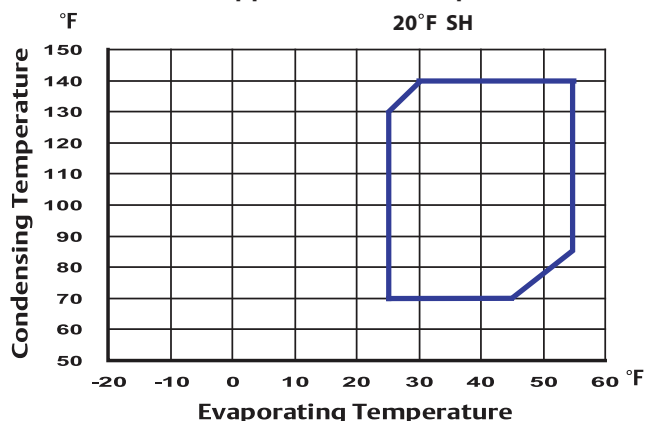


Figure 1E

ZB95KC & ZB114KC Application Envelope for R22 HT Applications 7-15Hp



Voltage / Frequency Restrictions

Due to inadequate cooling from refrigerant flow through the compressor, the following 50 Hz applications are not approved:

ZB95KC / ZB95KCE / ZB114KC / ZB114KCE-TWD
420 V 50 Hz

ZB95KC / ZB95KCE / ZB114KC / ZB114KCE-TW5
200-220 V 50 Hz

Compressor Lubrication

The compressors can be used with different lubricants depending upon the refrigerant used. See **Form 93-11** for a complete list of all Emerson approved lubricants.

Accumulators

Due to the inherent ability of scroll compressors to handle liquid refrigerant in flooded start and defrost cycle operation conditions, accumulators may not be required. An accumulator is required on single compressor systems when the charge limitations exceed those values listed in **Table 2**. On systems with defrost schemes or transient operations that allow prolonged uncontrolled liquid return to the compressor, an accumulator is required unless a

TABLE 2
CHARGE LIMITS

Model Family	Charge Limits
ZB50, 58, 66, 76, 88, 95, 114 KC/E	16 lbs
ZB56,68,75,92KC/E & ZB11MC/E	17 lbs

suction header of sufficient volume to prevent liquid migration to the compressors is used. Excessive liquid floodback or repeated flooded starts will dilute the oil in the compressor causing inadequate lubrication and bearing wear. Proper system design will minimize liquid floodback, thereby ensuring maximum compressor life.

If an accumulator must be used, an oil return orifice size in the range of 0.040 - 0.075 inches (1 - 1.9 mm) is recommended. A large-area protective screen no finer than 30 x 30 mesh (0.6 mm openings) is required to protect this small orifice from plugging with system debris. Tests have shown that a small screen with a fine mesh can easily become plugged causing oil starvation to the compressor bearings.

Screens

The use of screens finer than 30 x 30 mesh (0.6 mm openings) anywhere in the system is not recommended. Field experience has shown that finer mesh screens used to protect thermal expansion valves, capillary tubes, or accumulators can become temporarily or permanently plugged with normal system debris and block the flow of either oil or refrigerant to the compressor. Such blockage can result in compressor failure.

**TABLE 3
CRANKCASE HEATERS**

Model	Part No.	Volts	Watts	Leads
ZB50, ZB58, ZB66, ZB76 ZB88, ZB95 ZB114	Select by voltage 018-0067-00 018-0067-01 018-0067-02 018-0067-03	120 240 480 575	90 90 90 90	48" 48" 48" 48"
ZB56 ZB68 ZB75 ZB92 ZB11M	Select by voltage and lead length 018-0077-00 018-0077-01 018-0077-02 018-0077-03 018-0077-04 018-0077-05 018-0077-06	240 120 480 575 240 480 575	70 70 70 70 70 70 70	26" 26" 26" 26" 34" 34" 34"

**TABLE 3A
CONDUIT READY HEATER BOX KITS**

Model Number	Kit Number
ZB50, ZB58, ZB66 ZB76, ZB88, ZB95, ZB114	998-7029-00
ZB56, ZB68, ZB75 ZB92, ZB11M	998-7015-00

Crankcase Heater

Crankcase heaters are required on systems when the system charge exceeds the recommended charge limit. See **Table 2**.

The listed crankcase heaters (**Table 3**) are intended for use only when there is limited access. The heaters are not equipped for use with electrical conduit. Where applicable, electric safety codes require heater lead protection, a crankcase heater terminal box should be used. Recommended crankcase heater terminal cover and box numbers are listed in **Table 3A**. If there are any questions concerning the application, contact the Emerson Climate Technologies Application Engineering department.

Advanced Scroll Temperature Protection (ASTP)

After extensive research and trials Emerson Climate Technologies found a way to install a Therm-O-Disc® temperature sensitive snap disc in the ZB50, ZB58, ZB66, ZB76, ZB95, ZB88 and ZB114 scroll compressors. This acts to protect the compressor from



Figure 2

discharge gas overheating. Events such as loss of charge, evaporator blower failure, or low side charging with inadequate pressure will cause the discharge gas to quickly rise above a critical temperature. Once this critical temperature is reached, the ASTP feature will cause the scrolls to separate and stop pumping but allow the motor to continue to run. After the compressor runs for some time without pumping gas, the motor protector will open. Depending on the heat build up in the compressor, it may take up to two hours for the ASTP to reset. The addition of the Advanced Scroll Temperature Protection makes it possible to eliminate the discharge line thermostat previously required. A graphic explanation and a short video clip are available on the web site, www.emersonclimatecontractor.com/ASTP. Compressors with this feature will have the Advanced Scroll Temperature Protection label (**Figure 2**) located directly above the terminal box.

Discharge Line Thermostat

The addition of the Advanced Scroll Temperature Protection on the ZB50, ZB58, ZB66, ZB76, ZB88, ZB95 and ZB114, as well as the internal discharge temperature protection described in the section titled “Motor Protection” for the ZB56, ZB68, ZB75, ZB92, and ZB11M, makes it possible to eliminate the discharge line thermostat in most applications.

Pressure Controls

Both high and low pressure controls are required and the following are the minimum and maximum set points. Refer to **Table 4** for proper settings.

IPR Valve

The 7 through 15 horsepower refrigeration scroll compressors DO NOT have an internal high pressure relief valve. To provide safe operation, a high pressure control set no higher than 445 psig must be used in all applications (reference **Table 4**).

Motor Protection

The larger horsepower refrigeration scroll compressors have either line break protection or the use of sensors with an electronic module. The type of protection is obtained from the protector code in the model number. **Table 5** lists the various models protector number and the type of protection.

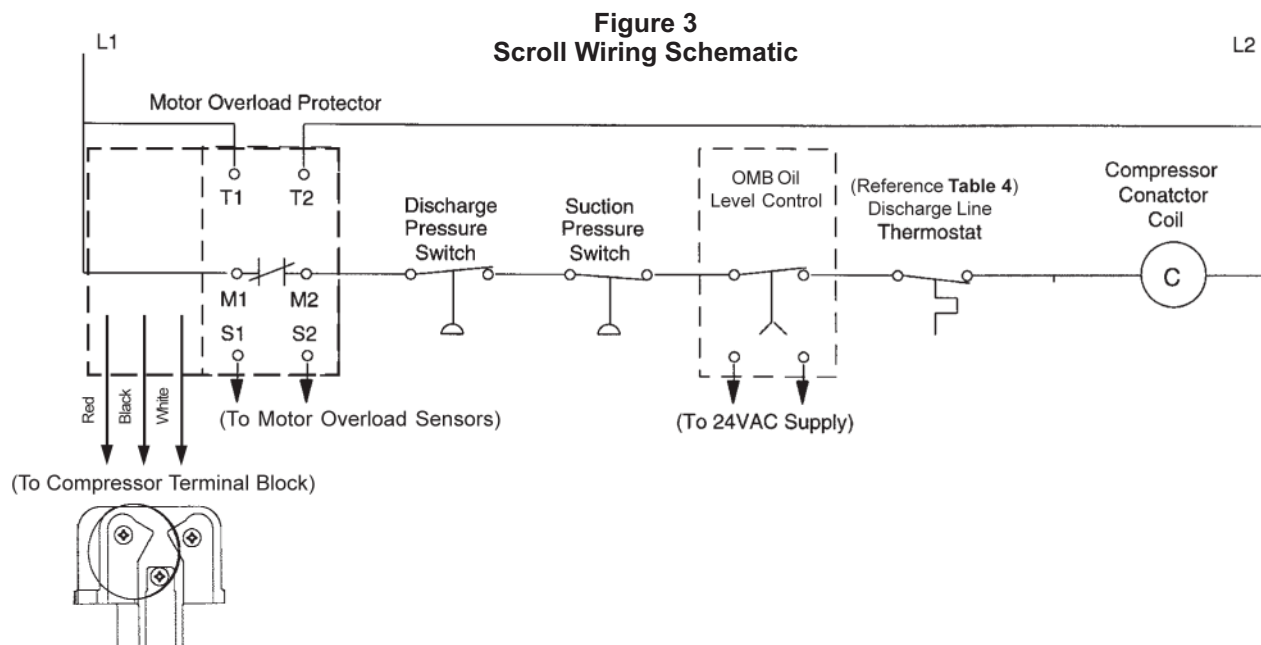
For the INT69SCY, there are five PTC (positive temperature coefficient) internal thermistors connected in series that react with avalanche resistance in the event of high temperatures. Four of the thermistors are

TABLE 4
PRESSURE CONTROL SETTINGS

Model	Control Type	R404A/R507	R134a	R22
ZB50, ZB58, ZB66, ZB76, ZB95, ZB114	Low High	17 psig min. 454 psig max.	4 psig min. 263 psig max	37 psig min. 381 psig max
ZB88	Low High	N/A N/A	N/A N/A	37 psig min. 381 psig max
ZB56, ZB75, ZB68, ZB92, ZB11M	Low High	17 psig min. 454 psig max.	4 psig min. 263 psig max	37 psig min. 381 psig max

TABLE 5
MOTOR PROTECTION

Models with Line Break Protection ZB50, ZB58, ZB66, ZB76, ZB88, ZB95, ZB114 (note: electric code = TF*)	No module
Models with Electronic Module ZB56, ZB68, ZB75, ZB92, ZB11M (note: electric code = TW*)	p/n: 071-0620-00 Model: INT69SCY
Models with Electronic Module ZB95, ZB114 (note: electric code = TW*)	p/n: 071-0641-00 Model: INT69SU



used to sense motor temperatures and the fifth is used as a discharge temperature sensor. For the INT69SU, there are four PTC (positive temperature coefficient) internal thermistors connected in series. All four are used to sense motor temperature. The thermister circuit is connected to the protector module terminals S1 and S2.

When any thermister reaches a limiting value, the module interrupts the control circuit and shuts off the compressor. After the thermister has cooled sufficiently, the resistance will decrease, thus allowing the module to reset. However, the module has a 30-minute time delay before reset after a thermister trip.

For all other compressors, conventional internal line break motor protection is provided.

Programmable Logic Controller Requirements

If the INT69SCY (071-0620-00) or INT69SU (071-0641-00) module is applied in conjunction with a Programmable Logic Controller, it is important that a minimum load is carried through the M1-M2 control circuit contacts.

The minimum required current through the module relay contacts needs to be greater than 100 milliamps but not to exceed 5 amps. If this minimum current is not maintained, this has a detrimental effect upon the long-term contact resistance of the relay and may result in false compressor trips.

PLC operated control circuits may not always provide this minimum current. In these cases modifications to the PLC control circuit are required. Consult your application engineering department for details.

Phase Protection

The INT69SCY module provides phase protection for the compressor. The module senses the correct phase sequence, phase loss and voltage sag for each leg (L1, L2 and L3) of the incoming power supplied to the compressor. At installation the three phases of the power supply must be wired in the correct 120° phase sequence. This will ensure the compressor will start and operate in the correct clockwise direction.

The INT69SCY module trips (M1-M2 contacts open) when the module senses a phase loss. There is a 5 minute time delay before the module attempts a restart. If all three phases are present, then the module will reset (M1-M2 contacts will close) and the compressor will start and run. If not, the module will attempt a restart after another 5 minute time delay. After 10 failed attempts to restart, the module will lock-out (M1-M2 contacts will remain open) and can only be reset by removing the power from T1-T2 for a minimum of 5 seconds.

The INT69SCY is intended to protect the compressor. The L1/L2/L3 and S1/S2 leads are pre-wired on the compressor and are engineered to work in conjunction with the motor protector module. The module

leads should not be moved or extended because of the possibility of inducing electronic noise into the INT69SCY, which could cause false trips of the module.

Module and Sensor Functional Check

The following field troubleshooting procedure can be used to evaluate the solid state control circuit: Refer to **Table 6** for a technical data summary.

Module Voltage Supply Troubleshooting

- Verify that all wire connectors are maintaining a good mechanical connection. Replace any connectors that are loose.
- Measure the voltage across T1-T2 to ensure proper supply voltage.
- Determine the control voltage by using a voltmeter

and then measure the voltage across the M1-M2 contacts:

- If the measured voltage is equal to the control volts then the M1-M2 contacts are open.
- If the measurement is less than 1 volt and the compressor is not running, then the problem is external to the INT69SCY or INT69SU module.
- If the voltage is greater than 1 volt but less than the control voltage, the module is faulty and should be replaced.

Sensor Troubleshooting

- Remove the leads from S1-S2, and then by using an ohmmeter measure the resistance of the incoming leads.

CAUTION: Use an Ohmmeter with a maximum

TABLE 6

Emerson P/N	071-0520-07	071-0520-05	071-0620-00	071-0641-00
Manufacturer P/N	T.I. 30AA201E	Kriwan 69SC-DV	Kriwan 69SCY	Kriwan 69SU
T1-T2 Module Power				
Voltage Supply	120V & 240V	120V & 240V	120V & 240V	120V & 240V
Frequency	50Hz & 60Hz	50Hz & 60Hz	50Hz & 60Hz	50Hz & 60Hz
M1-M2 Module Output Contacts				
Maximum Voltage	N/A	250VAC	250VAC	250VAC
Maximum Current	5 Amps	5 Amps	5 Amps	5 Amps
Minimum Current	100 milliamps	100 milliamps	100 milliamps	100 milliamps
Relay Output	2.5 A, 600 V	5 A, 300 VA	5 A, 300 VA	5 A, 300 VA
Power Output	< 5.5 VA	<3 VA	<3 VA	<3 VA
S1-S2 Thermal Protection				
Trip Out Resistance	N/A	4500W ± 20%	4500W ± 20%	4500W ± 20%
Reset Resistance	N/A	2750W ± 20%	2750W ± 20%	2750W ± 20%
Reset Time	30 min ± 5 min	30 min ± 5 min	30 min ± 5 min	30 min ± 5 min
Manual Reset	T1-T2 interrupt for minimum of 5 sec	T1-T2 interrupt for minimum of 5 sec	T1-T2 interrupt for minimum of 5 sec	T1-T2 interrupt for minimum of 5 sec
L1-L2-L3 Phase Monitoring				
Phase Sensor	Non Phase Sensing	Non Phase Sensing	3	Non Phase Sensing
Phase Monitoring Circuit Rating	Non Phase Sensing	Non Phase Sensing	3 AC 50/60Hz 120V to 632V	Non Phase Sensing
Trip Delay	Non Phase Sensing	Non Phase Sensing	5 min delay before restart attempt	Non Phase Sensing
Lockout	Non Phase Sensing	Non Phase Sensing	After 10 module trips	Non Phase Sensing
Reset For Lockout	Non Phase Sensing	Non Phase Sensing	T1-T2 interrupt for minimum of 5 sec	Non Phase Sensing

of 9 VDC for checking – do not attempt to check continuity through the sensors with any other type of instrument. Any external voltage or current may cause damage requiring compressor replacement.

- a. During normal operation, this resistance value should read less than 4500 ohms $\pm 20\%$.
 - b. If the M1-M2 contacts are open, the measured S1-S2 value is above 2750 ohms $\pm 20\%$ and the compressor has been tripped less than 30 minutes then the module is functioning properly.
- If the S1-S2 wire leads read less than 2750 ohms $\pm 20\%$ and the M1-M2 contacts are open, reset the module by removing the power to T1-T2 for a minimum of 5 seconds.
 - Replace all wire leads and use a voltmeter to verify the M1-M2 contacts are closed.
 - If the M1-M2 contacts remain open and S1-S2 are less than 2500 ohms, remove leads from the M1-M2 contacts and jumper together;

CAUTION: Compressor should start at this time. HOWEVER DO NOT LEAVE JUMPER IN PLACE FOR NORMAL SYSTEM OPERATIONS. THE JUMPER IS USED FOR DIAGNOSTIC PURPOSES ONLY.

- Go to Compressor Supply Voltage Troubleshooting.

Compressor Voltage Supply Troubleshooting

- Remove phase sensing leads from the module from L1/L2/L3.
- Use a voltmeter to measure the incoming 3 phase voltage on L1/L2/L3. WARNING: L1/L2/L3 could

be at a potential up to 600VAC.

- Ensure proper voltage on each phase.
- Remove power to the module for a minimum of 5 seconds to reset and replace all wire leads. Re-energize the module. If the M1-M2 contacts are open with proper voltage to T1-T2, L1/L2/L3 and proper resistance to S1-S2 then the module is faulty and should be replaced.

Oil Type

Polyol ester lubricant (POE) must be provided if the refrigeration scroll is used with HFC refrigerants.

Copeland Scroll refrigeration compressors intended for use with R22 are supplied with mineral oil.

Reference **Table 7** for proper oil charge. See **Form 93-11** for a complete list of all Emerson approved lubricants.

Oil Management for Single Compressor Applications

If the oil level is above the sight glass, oil circulation rates greater than 1.5% may be experienced with the ZB50, ZB58, ZB66, ZB76, ZB88, ZB95 & ZB114 compressors. This is especially true in the larger compressors in 60 Hz applications.

Oil Management for Rack Applications

Copeland Scroll refrigeration compressors may be used on multiple compressor parallel rack applications. This requires the use of an oil management system to maintain proper oil level in each compressor crankcase. The sight glass connection supplied can accommodate the mounting of the oil control devices.

Unlike Semi-Hermetic compressors, the scrolls do not have an oil pump with accompanying oil pressure safety controls. Therefore, an external oil level control is required.

The OMB Oil Level Management Control combines the functions of level control and timed compressor shut-off should the level not come back to normal within a set period of time. This device has been found to provide excellent performance in field tests on Scroll compressors and is recommended for parallel system applications.

Note: Emerson Climate Technologies' Application Engineering Department should be contacted for approved oil management systems.

TABLE 7 COMPRESSOR OIL CHARGE		
Model	Initial	Recharge
ZB50	85	81
ZB58	85	81
ZB66	110	106
ZB76	110	106
ZB88	110	106
ZB95	110	106
ZB114	110	106
ZB56	140	137
ZB68	140	137
ZB75	140	137
ZB92	140	137
ZB11M	140	137

Immediately after system start-up the oil reservoir level will fluctuate until equilibrium is reached. It is advisable to monitor the oil level during this time to assure sufficient oil is available. This will prevent unnecessary trips of the oil control system.

Note: If oil management problems are occurring please refer to AE 17-1320 or contact the Emerson Climate Technologies Application Engineering Department.

Note: ZB50, 58, 66, 76, 88, 95, 114 are not approved for rack applications due to compressor limitations.

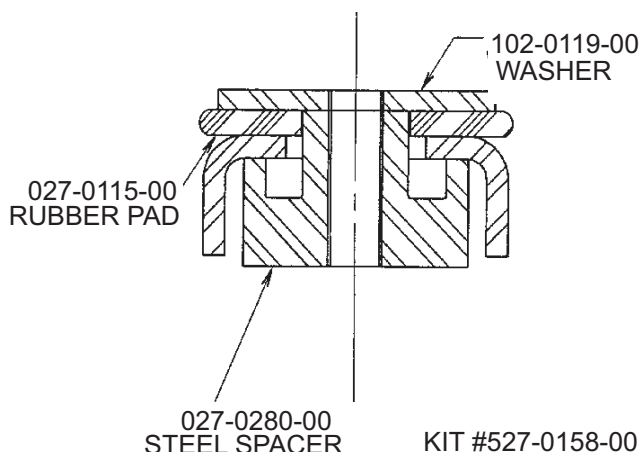
Compressor Mounting

Compressor mounting must be selected based on application. Consideration must be given to sound reduction tubing reliability. Some tubing geometry or “shock loops” may be required to reduce vibration transferred from the compressor to external tubing.

Mounting for Rack Systems

Specially designed steel spacers and rubber isolator pads are available for our refrigeration scroll 7.5-15 HP scroll rack applications. This mounting arrangement limits the compressors motion thereby minimizing potential problems of excessive tubing stress. Sufficient isolation is provided to prevent vibration from being transmitted to the mounting structure. This mounting arrangement is recommended for multiple compressor rack installations. See **Figure 4** for a detail for this mounting system.

Figure 4
7.5 - 15 HP Rack Mounting



Note: The use of standard soft grommets is not recommended for our refrigeration scroll rack installations. These “softer” mounts allow for excessive movement that will result in tube breakage unless the entire system is properly designed.

Connection Fittings

There are various connection fittings available for Copeland Scroll refrigeration compressors. The various options are shown in **Table 8**.

Three Phase Scroll Compressors – Directional Dependents

Scroll compressors are directional dependent; i.e. they will compress in one rotational direction only. Three phase Scrolls will rotate in either direction depending on power phasing. Since there is a 50/50 chance of connected power being “backwards”, contractors should be warned of this. Appropriate instructions or notices should be provided by the OEM. To eliminate the possibility of reverse rotation a Copeland Phase Control line monitor, P/N 085-0160-00, or other phase monitor is recommended.

Verification of proper rotation can be made by observing that the suction pressure drops and the discharge pressure rises when the compressor is energized. Additionally, if operated in reverse the compressor is noisier and its current draw is substantially reduced compared to tabulated values.

TABLE 8

Model	Rotolock Spud Connection		Stub Connection	
	Suction	Discharge	Suction	Discharge
ZB50	1-3/4 - 12	1-1/4 - 12	1-1/8"	7/8"
ZB58	1-3/4 - 12	1-1/4 - 12	1-1/8"	7/8"
ZB66	1-3/4 - 12	1-1/4 - 12	1-3/8"	7/8"
ZB76	1-3/4 - 12	1-1/4 - 12	1-3/8"	7/8"
ZB88	1-3/4 - 12	1-1/4 - 12	1-3/8"	7/8"
ZB95	1-3/4 - 12	1-1/4 - 12	1-3/8"	7/8"
ZB114	1-3/4 - 12	1-1/4 - 12	1-3/8"	7/8"
ZB56	1-3/4 - 12	1-1/4 - 12	not offered	
ZB68	1-3/4 - 12	1-1/4 - 12	not offered	
ZB75	1-3/4 - 12	1-1/4 - 12	not offered	
ZB92	1-3/4 - 12	1-1/4 - 12	not offered	
ZB11M	2-1/4 - 12	1-3/4 - 12	not offered	

No time delay is required on three phase models to prevent reverse rotation due to brief power interruptions.

Deep Vacuum Operation

WARNING: Do not run a Copeland Scroll refrigeration compressor in a deep vacuum. Failure to heed this advice can result in arcing of the Fusite pins and permanent damage to the compressor.

A low pressure control is required for protection against deep vacuum operation. See Pressure Control section for proper set points.

Scroll compressors (as with any refrigerant compressor) should never be used to evacuate a refrigeration or air conditioning system. See **Application Engineering Bulletin AE 24-1105** for proper system evacuation procedures.

Unbrazing System Components

If the refrigerant charge is removed from a scroll unit by bleeding the high side only, it is sometimes possible for the scrolls to seal, preventing pressure equalization through the compressor. This may leave the low side shell and suction line tubing pressurized. If a brazing torch is then applied to the low side, the pressurized refrigerant and oil mixture could ignite as it escapes and contacts the brazing flame. It is important to check

both the high and low sides with manifold gauges before unbrazing or in the case of assembly line repair, remove refrigerant from both the high and low sides. Instructions should be provided in appropriate product literature and assembly (line repair) areas.

Hi-Pot Testing

Copeland Scroll compressors are configured with the motor in the bottom of the shell. Unlike most other hermetic compressors, the scroll motor can be immersed in refrigerant when liquid is present in the shell. Hi-Pot test with liquid refrigerant in the shell can show higher levels of current leakage due to higher electrical conductivity of liquid refrigerant vs. refrigerant vapor and oil. This phenomenon can occur with any compressor when the motor is immersed in refrigerant and does not present any safety issue. To lower the current leakage reading operate the system for a brief period of time, redistributing the refrigerant in a more normal configuration and test again.

Note: The solid state electronic module components and internal sensors are delicate and can be damaged by exposure to high voltage. Under no circumstances should a high potential test be made at the sensor terminals or sensor leads connected to the module. Damage to the sensors or module may result.

ADDENDUM

The contents of this publication are presented for informational purposes only and are not to be construed as warranties or guarantees, express or implied, regarding the products or services described herein or their use or applicability. Emerson Climate Technologies, Inc. and/or its affiliates (collectively "Emerson"), as applicable, reserve the right to modify the design or specifications of such products at any time without notice. Emerson does not assume responsibility for the selection, use or maintenance of any product. Responsibility for proper selection, use and maintenance of any Emerson product remains solely with the purchaser or end user.

CAUTION

POE must be handled carefully and the proper protective equipment (gloves, eye protection, etc.) must be used when handling POE lubricant. POE must not come into contact with any surface or material that might be harmed by POE, including without limitation, certain polymers (e.g. PVC/CPVC and polycarbonate).